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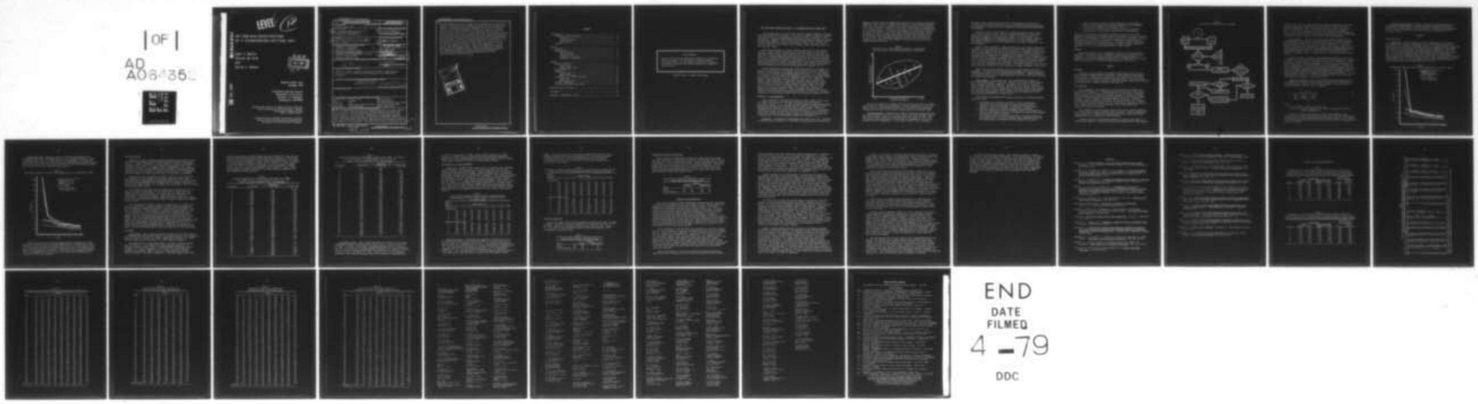

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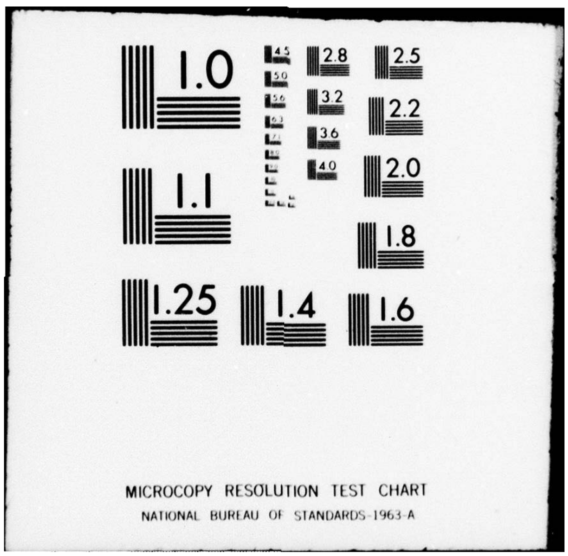
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AN ITEM BIAS INVESTIGATION OF A STANDARDIZED APTITUDE TEST

John T. Martin
Steven M. Pine
and
David J. Weiss

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RESEARCH REPORT 78-5
DECEMBER 1978

PSYCHOMETRIC METHODS PROGRAM
DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MN 55455

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racial bias	item calibration	factor composition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Verbal and quantitative data from a standardized aptitude test (SCAT, Series II, Level 2) were analyzed separately for Native American and White high school students. Item correlation matrices were factor analyzed for each group, separately for each ability. Coefficients of congruence comparing factor structures between groups were high for the first verbal factor and the first and second quantitative factors, implying that ability factor structures were similar for the two groups. The first factors were of sufficient size to

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allow parameterization of the items by item characteristic curve (ICC) methods. Item difficulty (*b*) parameters derived for the two groups were compared by regressing difficulty parameters for the Native American group on the difficulty parameters for the White group, and values of elliptic-D were computed for each item and group. Results led to the conclusion that there were no reliably biased items in the verbal subtest, while there were two reliably biased items in the quantitative subtest--one item biased against the Native American group and one biased against the White group. Internal consistency reliabilities were higher for the Native American group in both tests, and the scores of Native American students were better predictors of high school rank than were scores for the White students; but these results were significant ($p<.05$) only for the quantitative subtest. Results indicated that different approaches to the identification of bias led to different conclusions. Thus, additional research is needed to determine which indices of item and test bias yield the most meaningful approach to the analysis of bias in ability tests.

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Contents

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An Item Bias Investigation of a Standardized Aptitude Test

Over the last decade, concerns about test bias against members of minority races have dramatically increased. As a result, a number of different methods have been devised for investigating cultural and racial differences in test performance. Generally, these studies have been concerned with what are usually called culture-loaded or culture-biased tests (Jensen, 1974). However, there has been some attention focused on the problem of bias in ability tests at the test item level (e.g., Church, Pine, & Weiss, 1978) rather than solely at the test score level.

Bias may be difficult to define, however, where there is no criterion variable. Pothoff (1973) pointed out that "in many practical situations, a definition based on either [groups being alike with respect to mean score on each item or groups being alike simply with respect to mean total score] would appear to be on rather shaky ground, because it would be difficult to defend an a priori assumption of equality of the groups" (p. 75). He offered a well-reasoned example to show "that a bias-free test may not necessarily produce the same average scores for Negroes and Whites even if SES [socioeconomic status] is held constant and the races are equally genetically endowed" (p. 77).

Pothoff mentioned the interaction between item responses and groups as a method for defining bias in the absence of a criterion variable. However, he pointed out that absence of item-group interaction does not guarantee absence of bias, since all items may be biased against one group. Also, the presence of interaction does not necessarily demonstrate bias "because different groups may be strong on different types of relevant items" (p. 3). Using the example of sex differences in vocabulary test items (boys do better with "thing" items, while girls do better with "people" items), Pothoff stated that "item-group interaction might represent 'balance' rather than 'bias'" (p. 91); as long as there is a proper ratio of "people" items to "thing" items, the test is not sexually biased. Of course, these decisions of "balance" are somewhat arbitrary. Pothoff therefore concluded that he was "unable to find an objective statistical definition of bias which is generally satisfactory for the situation where there is no criterion variable" (p. 82).

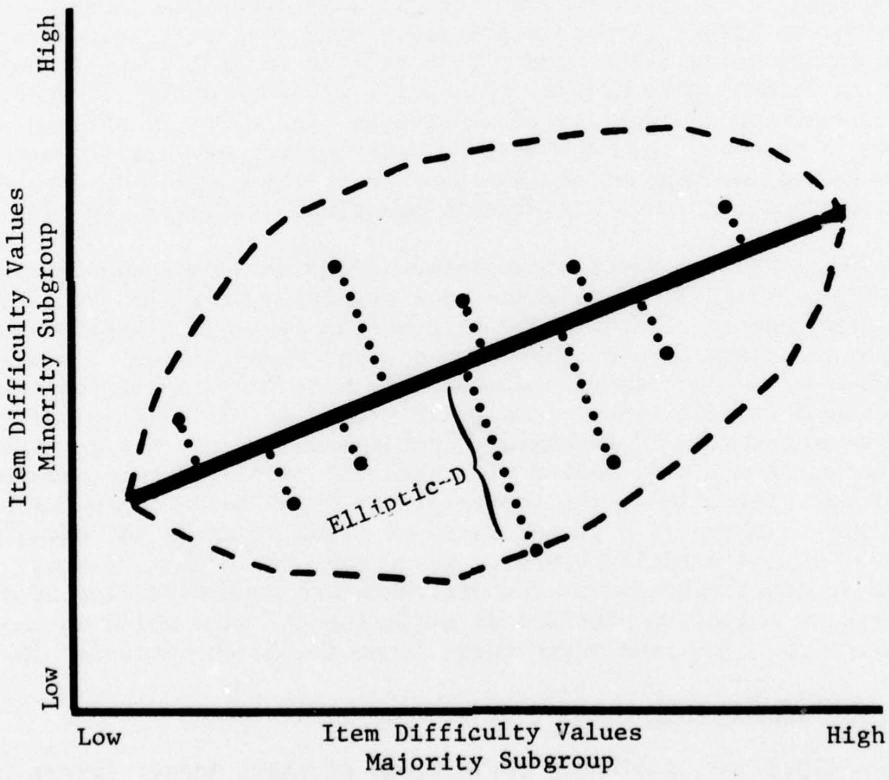
Methods for Identifying Bias

From an analysis of dictionary definitions of bias, Angoff (1975) found as a common idea that bias "represents a deviation from straightness, rectitude, or truth" (p. 2). He drew the basic distinction between identifying bias with or without a criterion and found the logical circularity of much thought about bias without a criterion to be a major problem: "How do I distinguish test bias from social and educational bias?" (p. 4). He believed that one must assume the main body of the test is unbiased, and then look for "items that tend more than the others to favor one group over the other and to misrepresent the true differences between the two groups"(p. 6).

Elliptic-D. The method for identifying those items is not new. According to Angoff, Thurstone defined it in the 1920s in conjunction with his Method of

Absolute Scaling, and it has subsequently been used in a variety of related ways (Thurstone, 1925; Cardall & Coffman, 1964; Cleary & Hilton, 1968; Gulliksen, 1964). By this method, transformed item difficulty values are calculated for two different groups on a number of test items. These values are then plotted on a bivariate graph, with each pair represented by a point on the graph, as illustrated in Figure 1. The points will normally form an ellipse. As the two groups become increasingly less similar in their item difficulty values, the points are found at greater and greater distances from the major axis of the ellipse. The perpendicular distance from the axis to any point is "elliptic-D," an index of item-by-subgroup interaction which can be used to identify biased test items.

Figure 1
Bivariate Plot of Item Difficulty Values on a 10-Item Test
for Two Groups, Illustrating Computation of Elliptic-D



The use of elliptic-D to examine item bias requires that data on a number of test items be examined simultaneously. Items are identified as biased if their value of D, representing the distance of the item from the line drawn through the major axis of the ellipse, is large relative to the other items.

ICC-based methods. The concept of using ICC theory for testing item bias was first proposed by Pine (1975a, 1975b, 1977); Lord (1977) and Marco (1977) have also described a method of examining single test items for bias. With this method, item characteristic curves (ICCs) are compared for the two (or more) groups under consideration. If an item is found to have a different

difficulty value (location on the trait) or discrimination value (slope of the ICC) when the item characteristic curve is plotted for different subgroups, the existence of subgroup bias or an exceptional item-by-group interaction may be suspected.

Green and Draper's (1972) method for evaluating item bias also is based on ICC theory. By this method, ICCs are plotted separately for each item within each subgroup, and the plots are compared. An item is said to be unbiased if examinees of the same ability level, but from different subgroups, have equal probabilities of responding correctly. A major weakness with this approach, however, is that the comparison of the ICCs is judgmental and not quantified.

Rudner (1977a) preferred to identify biased test items using a method which is similar to Green and Draper's method, but which involves equating the parameters for two subgroups for their ability variances. According to Rudner, this can be accomplished by computing the regressions of the parameter values based on one group of examinees on the parameter values based on the other group of examinees. When the measure is unidimensional, contains locally independent items, and has error-free parameter estimates, the ICCs of the two groups will be identical. Failure of the ICCs to be identical is indicative of non-unidimensionality, i.e., the item is measuring either different traits between groups or a trait other than that measured by the other items. In Rudner's approach, bias is quantifiable using the residuals from the regression to gauge the extent of item bias.

Rudner (1977a) used this method of item bias investigation with three subgroups: (1) low-ability hard-of-hearing individuals, (2) high-ability hard-of-hearing individuals, and (3) normal-hearing individuals. Equated parameters were similar for the two hard-of-hearing groups, but not for the hard-of-hearing vs. normal-hearing groups.

Other methods. Factor analysis of test item responses has also been used in the investigation of test bias. Church, Pine, & Weiss (1978) reported factor analyses of verbal, numerical, and spatial test items for groups of Black and White high school students. Comparisons of the factor structures of the two groups indicated little similarity in structures between the two groups for any of the tests. Using a simple index of item bias based on differences in ICC difficulty parameters, one of the factors of the verbal test in the White group was identified as a "bias" factor.

Rudner (1977b) has summarized the various approaches to identifying biased items as follows:

1. *Transformed item difficulty approaches*, in which within-group item difficulty is standardized and compared between groups.
2. *Analysis of variance approaches*, in which bias is operationally defined in terms of significant item-by-group interaction.
3. *Chi-square approaches*, in which individual items are investigated in terms of between-group score level differences in expected and observed proportions of correct responses.
4. *Item characteristic curve theory approaches*, in which differences in the probabilities of a correct response, given examinees of the same underlying ability and different culture groups, are evaluated.

5. *Factor analytic approaches,* in which item bias is investigated in terms of culture-specific and culture-common sources of variance or in terms of loadings on a bias test factor.
6. *Distractor response analysis approaches,* in which the relative attractiveness of item response alternatives is investigated.

Rudner feels that because of problems involved with using phi, phi over phi-max, or tetrachoric correlations in the factor analysis, the factor analytic approach to identification of biased items is difficult to implement. He also indicated that it is difficult to obtain a clear factor structure because inter-item correlations are typically low. Distractor response analysis and chi-square analysis are considered favorably by Rudner; however, there have apparently been as yet no major applications of these methods.

Purpose

Because of problems in the application of each of the major methods of identifying biased test items, a systematic combination of approaches seems appropriate. The present report describes such a systematic approach, applying to data from a standardized aptitude test a combination of the factor analytic approach and a latent-trait-based variation of elliptic-D.

Method

Subjects

Subjects for this research were 129 Native American and 251 White high school juniors attending school in Minnesota. Native American participants were selected at random from the data files of the Statewide Testing Service of the University of Minnesota Student Counseling Bureau. White participants were selected on the basis of being the first White student whose record followed a selected minority student's record on the data tape.

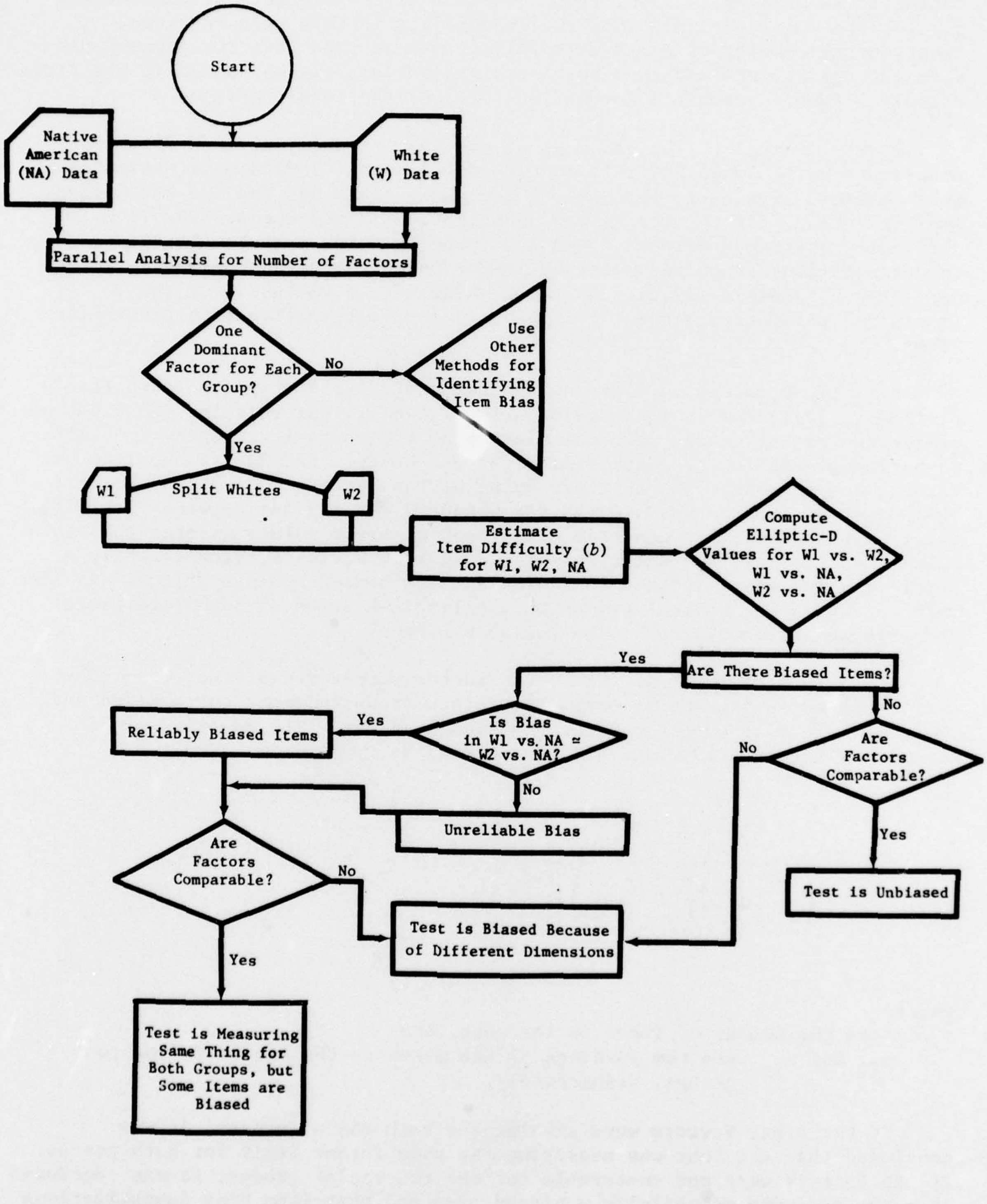
Data Analysis

Factor analysis. The procedure for testing item bias is summarized in the flow chart in Figure 2. Item response data from the School and College Ability Test (SCAT), Form 2B, were obtained for the two groups. Tetrachoric intercorrelations were computed from testee responses to the 50-item verbal (V) and 50-item quantitative (Q) subtests separately for the Native American and White groups (omitted items were scored as incorrect). Because of extreme response proportions, tetrachoric correlations could not be computed for 4 items in the verbal subtest and for 3 items in the quantitative subtest. Thus, subsequent factor analyses were based on 46 verbal items and 47 quantitative items in each group.

The tetrachoric intercorrelation matrices were factor analyzed separately for the two groups, using a principal factors solution. Initial communalities were estimated by the maximum off-diagonal value for each item, and observed communalities were iterated until they stabilized.

Randomly generated item responses matching the real data for numbers of variables and number of "subjects" were also intercorrelated and factor analyzed

Figure 2
Flow Chart for the Analysis of Item Bias



using the same solution; eight factors were arbitrarily extracted from each of the four matrices. Using the parallel analysis criterion for factor retention (Humphreys & Ilgen, 1969), those real data factors accounting for more of the total variance than the random data factors were retained. Based on the results of Reckase (1977), it was assumed that ICC parameterization was appropriate and that further bias analysis was warranted if the first principal factor accounted for at least 10% of the total variance.

Item bias index. The White group was then randomly divided into two subgroups--White 1 and White 2; and ICC difficulty (b) parameter estimates were obtained separately for each of the White subgroups and for the Native American group, for the verbal and quantitative item subsets. The item difficulty estimates were obtained by a program which computed latent trait a (discrimination) and b parameter estimates based on the approximation method described by Jensema (1976). A fixed value of .25 was used for the c (guessing) parameter, since all items were four-alternative multiple-choice items.

Elliptic-D values, defined as the perpendicular distance of each item's difficulty (b) value from the major axis of the ellipse relating the b values of the two racial groups were calculated for the White 1 vs. White 2 b-value comparisons, and for the Native American vs. White 1 and Native American vs. White 2 comparisons. The absolute value of the largest White 1 vs. White 2 elliptic-D difference was used as the standard for maximum between-race difficulty differences. Between-race elliptic-D absolute values greater than this value indicated an item which was biased against Native Americans, while a negative value of elliptic-D indicated an item biased against Whites. An item which exceeded the White 1 vs. White 2 elliptic-D value on both interracial comparisons was considered to be reliably biased.

Comparison of factors. Next, the factor structures of the two groups were compared as indexed by both the Pearson product-moment correlation and the coefficient of congruence for the item loadings. The coefficient of congruence (Rummel, 1970, p. 462) is defined as

$$\delta_{lq} = \frac{\sum_{j=1}^{N} \alpha_{jl}\, \alpha_{jq}}{\left[\left(\sum_{j=1}^{N} \alpha_{jl}^2\right)\left(\sum_{j=1}^{N} \alpha_{jq}^2\right)\right]^{1/2}} \qquad [1]$$

where

N is the number of items in the test, and

α_{jl} and α_{jq} are the loadings of the items on the factor in the two groups, respectively.

If the first factors were similar for both racial groups, it was concluded that the test was measuring the same latent trait for both groups. If the factors were not comparable for the two racial groups, it was concluded that the test was essentially a biased test and that item bias investigations were not relevant.

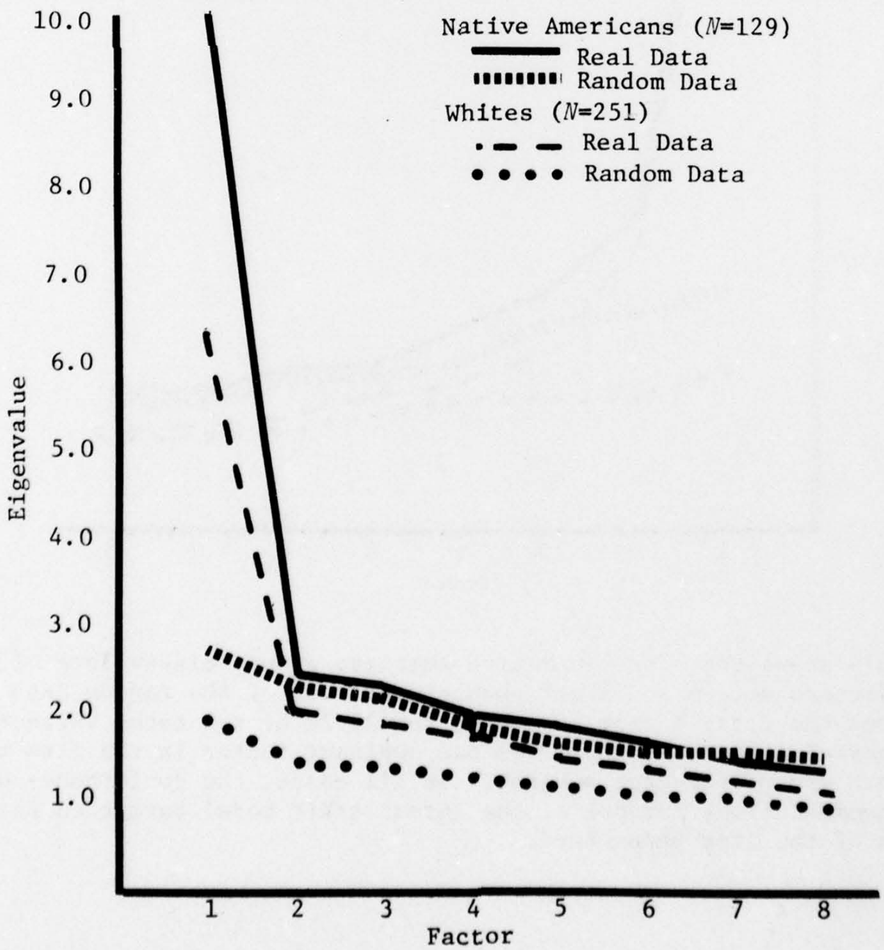
Reliability and validity. Internal consistency reliabilities were also calculated for V and Q scores for the total White group and for the Native American group using Cronbach's alpha coefficient. Correlations of SCAT-V and SCAT-Q scores with high school rank were also computed separately for the two racial groups.

Results

Number of Factors

Verbal items. Figure 3 shows plots of the eigenvalues for eight factors extracted from the real and random data for both Native American and White groups (numerical values are in Appendix Table A). As Figure 3 shows, eigenvalues of the eight real data factors were larger than the eigenvalues of the random data factors in the White group. The first factor accounted for 13.8% of the total variance, thus warranting ICC parameterization of the White group verbal data. In the Native American group, six real data factors had eigenvalues greater than the corresponding random data eigenvalues. For this group, the first factor accounted for 21.7% of the total variance, again meeting Reckase's (1977) recommendation that it contain at least 10% of the total variance in order to warrant latent trait item parameterization of the data.

Figure 3
Random Data Eigenvalues and Real Data Eigenvalues for 46 Verbal Items



Quantitative items. Numerical values of the extracted eigenvalues for both groups and for real and random data are shown in Appendix Table B; Figure 4 summarizes these data. As shown in Figure 4, eigenvalues of the eight real data factors were larger than eigenvalues of the corresponding random data factors for the White group. The first factor accounted for 18.0% of the total variance, which allowed further item parameterization analysis.

Figure 4
Random Data Eigenvalues and Real Data Eigenvalues for 47 Quantitative Items

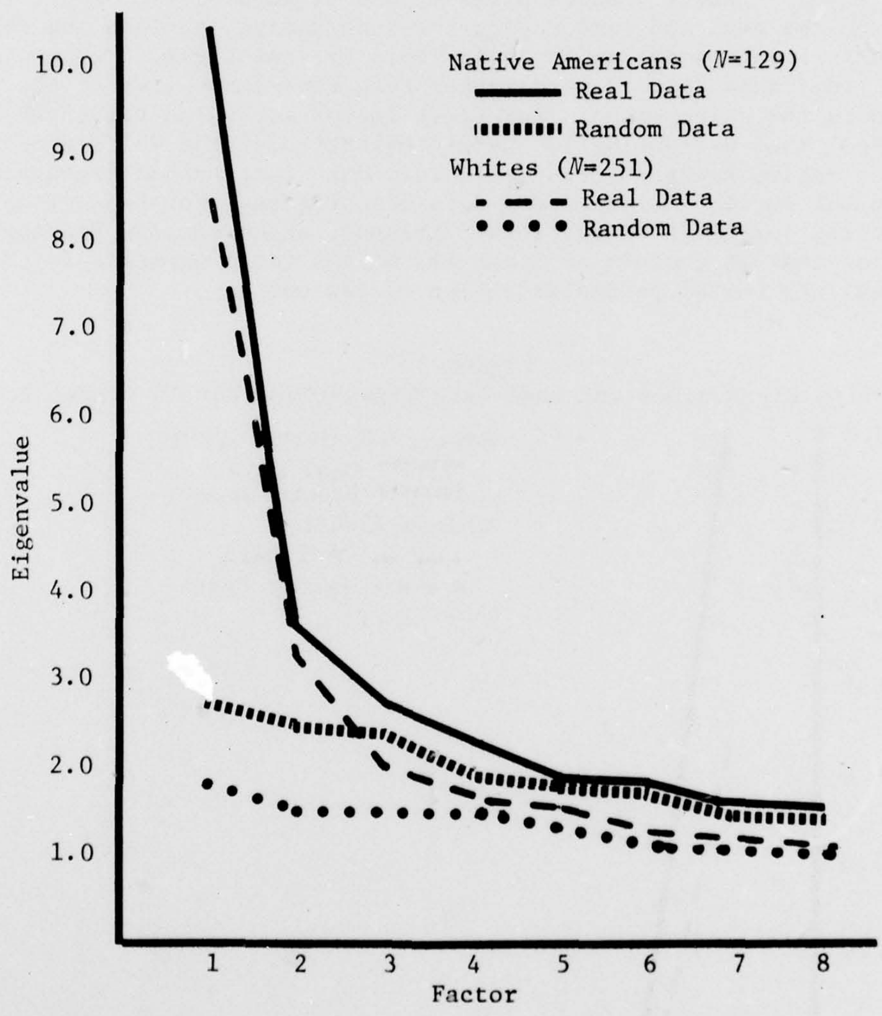


Figure 4 shows that for the Native American group, eigenvalues of eight real data factors were also larger than eigenvalues of the random data factors. In that group the first factor accounted for 22.2% of the total variance. Thus, as in the verbal item data, there was one dominant factor in the item response data for both groups for each subtest. In all cases, the conformance of these data to recommendations for use of the latent trait model permitted the ICC calibration of the item parameters.

Item Difficulties

Values of the ICC *b* parameter estimates for verbal and quantitative items for the two White subgroups and the Native American group are in Appendix Table C. As Table C indicates, it was not possible to obtain item parameter estimates for all items. For items on which the proportion correct was less than or equal to the *c* parameter (.25), *b* parameters were not estimated. Similarly, for items on which the biserial correlation of item response with total score was 1.0 or greater, *b* values were not computed. All subsequent analyses included only those items for which *b* values could be estimated.

Examination of the *b* parameters in Table C reveals that the items were more difficult, on the average, for the Native Americans in both tests. The difference in difficulties was nearly one-half of a θ unit, as the average *b* value for Native Americans was .48 higher than the average *b* value for Whites on the verbal subtest and .45 higher than the average *b* value for Whites on the quantitative subtest.

Item difficulty (*b*) values for the verbal items correlated .83 for the White 1 vs. White 2 comparison, .85 for the White 1 vs. Native American comparison, and .78 for the White 2 vs. Native American comparison. The coefficients of congruence for these *b* values were .85, .74, and .71, respectively. These results suggest a general similarity among the *b* values for the two racial groups on the verbal items, at least in terms of the pattern of the *b* values.

For the quantitative items, *b* values correlated .92 for the White 1 vs. White 2 comparison and .88 for both White vs. Native American comparisons. The coefficient of congruence for these *b* values was .92 for the White 1 vs. White 2 comparison, .76 for the White 1 vs. Native American comparison, and .80 for the White 2 vs. Native American comparison. Although the correlations suggest a similarity in the *b* values, the congruence coefficients suggest that they are less similar between racial groups than within racial groups. Since the congruence coefficient accounts for both the level and pattern of *b* values, while the correlation reflects only the patterning or rank order, these data suggest that there are differences between the levels of difficulties between the two racial groups. Examination of the data in Table C indicates a general tendency for the *b* values of the Native American group to be more concentrated around their mean than those of the White group.

Elliptic-D

Verbal items. Table 1 shows the elliptic-D values for the verbal items not eliminated from the analysis because of *b* estimates greater than an absolute value of 3.00, for the White 1 vs. White 2 comparison, the White 1 vs. Native American comparison, and the White 2 vs. Native American comparison.

The absolute value of the maximum White 1 vs. White 2 elliptic-D value was 1.052 (Item 5). In the White 1 vs. Native American comparison, the absolute elliptic-D value of Item 45 (1.082) exceeded the maximum value in the White 1 vs. White 2 comparison. In the White 2 vs. Native American comparison, the absolute value of Item 2 (-1.306) exceeded the maximum value in the White 1 vs. White 2 comparison. These data suggest little bias

in these items, and no reliably biased items were identified in which the same items were identified as biased in both interracial comparisons. The one item, Item 45, which was identified as biased against Native Americans in the White 1 vs. Native American comparison, however, had an elliptic-D of .984 in the White 2 vs. Native American comparison; this was only .068 lower than the highest value in the White 1 vs. White 2 comparison. These data suggest a tendency of that item to be reliably biased against Native Americans. Item 2, which was identified as biased in the White 2 vs. Native American comparison, had been eliminated from the analysis.

Table 1
Values of Elliptic-D for Verbal Items for the White 1 vs. White 2 (W1 vs. W2), White 1 vs. Native American (W1 vs. NA), and White 2 vs. Native American (W2 vs. NA) Subgroups

	Subgroups		
Item Number	W1 vs. W2	W1 vs. NA	W2 vs. NA
2	---	---	-1.306
3	.100	-.894	-.783
4	.333	-.375	-.393
5	1.052	.261	-.027
6	-.071	-.230	-.072
7	-.209	-.460	-.235
8	.594	-.669	-.785
9	-1.024	.320	.905
10	-.364	-.213	.079
11	---	---	-.161
12	-.165	.242	.462
13	.195	.212	.247
14	.225	.122	.146
15	-.874	-.864	-.352
16	.517	.032	-.019
17	-.189	-.015	.176
18	-.372	-.577	-.272
19	.009	-.517	-.377
20	.493	-.332	-.390
21	.402	.076	.033
22	.403	.316	.271
24	-.290	-.130	.117
25	-.448	-.132	.183
26	.618	.480	.320
27	---	-.407	---
28	.043	.002	.119
29	-.306	.309	.536
30	-.128	---	---
31	---	.830	---
32	.217	.191	.201
34	---	.652	---
35	-.772	.048	.473
36	.400	-.133	-.216
39	.057	.082	.135
41	-.450	.689	.984
45	---	1.082	---

Table 2
Values of Elliptic-D for Quantitative Items for the White 1 vs. White 2 (W1 vs. W2), White 1 vs. Native American (W1 vs. NA), and White 2 vs. Native American (W2 vs. NA) Subgroups

Item Number	Subgroups		
	W1 vs. W2	W1 vs. NA	W2 vs. NA
2	---	-.628	---
4	---	.164	---
5	---	---	-1.040
6	-.124	-.001	.314
8	-.298	-.165	.107
9	.583	.511	.200
10	-.007	.061	.110
11	-.079	.056	.179
12	.156	.068	.095
13	.130	.152	.115
14	.389	-.210	-.586
15	-.671	-.089	.592
16	.330	.103	-.037
17	.133	.049	.008
18	.063	.141	.275
19	-.105	-.218	-.097
20	-.273	---	---
21	-.248	-.526	-.146
22	-.242	-.317	-.070
23	-.091	-.067	-.018
24	.176	-.163	-.280
25	-.244	-.325	-.140
26	-.187	.284	.401
27	.145	.185	.082
28	-.160	.002	.045
29	.116	.179	.053
30	.689	1.371	.697
31	.156	.183	.118
32	---	.131	---
34	.228	.198	.020
35	-.465	-.464	-.219
36	-.096	.459	.388
37	.104	-.882	-.826
38	.403	-.539	-.647
40	.268	.037	-.120
43	-.466	.259	.427
44	-.315	---	---

Quantitative Items. Table 2 shows the values of elliptic-D for all group comparisons based on b values between +3.00 and -3.00. As Table 2 shows, for the White 1 vs. White 2 comparison, the maximum absolute value for elliptic-D was .689. In the White 1 vs. Native American comparison, two items had absolute values of elliptic-D which exceeded this value--Item 30 with an elliptic-D of 1.371 and Item 37 with an elliptic-D of -.882. In the White 2 vs. Native American comparison, three items had absolute values which exceeded the maximum White 1

vs. White 2 value--Item 5 (-1.040), Item 30 (.697), and Item 37 (-.826). Because of the high values of elliptic-D in both interracial comparisons, Items 30 and 37 can be designated as reliably biased items; Item 30 is biased against Native Americans and Item 37 is biased against Whites.

Comparability of Factor Structures

Verbal test. Appendix Tables D and E give the unrotated factor loadings on the six factors extracted from the Native American data and the eight factors extracted from the White data. Table 3 summarizes the relationships among these unrotated factor loadings using both product-moment correlations among factor loadings and the coefficient of congruence. The correlation between the loadings for the first factor was .64, while the coefficient of congruence for this factor was .94. The highest correlation among the other factors was .39--Factor 3 in the Native American group and Factor 5 in the White group. These two factors also obtained the highest coefficient of congruence (also .39). Thus, only the first factor of SCAT-V data was similar between groups. For the Whites, this factor accounted for 13.8% of the total variance; for the Native Americans, it accounted for 21.9% of the total variance (see Appendix Table A).

Table 3
Correlation and Congruence Coefficients for Unrotated Factor Loadings Between Whites (N=251) and Native Americans (N=129) for Verbal Items

Native American Factors	White Factors 1	2	3	4	5	6	7	8
Correlations								
1	.64	-.14	-.14	.08	-.01	-.40	.03	.14
2	-.05	-.19	.05	-.17	-.07	.12	-.19	-.16
3	-.35	.28	.15	.06	.39	-.24	-.01	.04
4	-.02	-.33	.07	-.03	.27	-.07	-.06	-.17
5	-.26	.17	.11	-.07	-.14	.24	.06	-.01
6	-.10	.27	.17	-.01	-.25	-.03	-.11	.03
Congruence Coefficients								
1	.94	.06	.06	.04	.03	-.03	.06	.05
2	.07	-.17	.06	-.16	-.07	.13	-.19	-.16
3	-.12	.28	.15	.06	.39	-.24	-.01	.04
4	.08	-.32	.08	-.03	.27	-.06	-.05	-.17
5	-.05	.17	.11	-.07	-.14	.24	.07	-.01
6	-.03	.27	.17	-.01	-.25	-.02	-.11	.03

Quantitative Test. Correlations and congruence coefficients for the unrotated factor loadings are presented in Table 4; the factor matrices for the two groups are in Appendix Tables F and G. The correlation between the first factors in the two groups was .73, and the coefficient of congruence was .94. The correlation of the second factors was .70, and the coefficient of congruence was .69. The next highest correlation was -.40 (congruence coefficient = -.39) between Factor 3 of the Native American data and Factor 4 of the White data. Only the first two factors were very similar between

groups. For the Whites, the first factor accounted for 18.0% of the total variance, and the second factor accounted for 7.1% of the total variance (see Appendix Table B). For the Native Americans, the first factor accounted for 22.1% of the total variance and the second accounted for 7.6% of the total variance.

Table 4
Correlation and Congruence Coefficients for Unrotated Factor Loadings Between Whites (N=251) and Native Americans (N=129) for Quantitative Items

Native American Factors	White Factors 1	2	3	4	5	6	7	8
Correlations								
1	.73	-.47	-.13	-.22	-.28	-.11	-.14	-.09
2	-.23	.70	-.09	.18	.37	.06	.09	-.13
3	.15	.15	-.22	-.40	.12	.08	-.12	-.14
4	-.16	.24	-.13	.13	-.32	.33	.20	.05
5	.02	.02	-.28	-.05	.09	-.11	.16	.10
6	-.17	.16	.12	.00	.04	-.15	-.24	.17
7	-.34	-.11	.25	-.22	.05	-.09	.31	.08
8	-.06	.04	-.13	.09	-.08	.11	-.18	.03
Congruence Coefficients								
1	.94	-.15	.03	.01	-.11	-.05	-.02	.05
2	.16	.69	-.05	.21	.36	.05	.10	-.10
3	.10	.15	-.22	-.39	.12	.08	-.11	-.14
4	.03	.25	-.11	.15	-.31	.33	.21	.06
5	.04	.02	-.27	-.04	.09	-.11	.16	.11
6	.01	.17	.13	.01	-.04	-.15	-.23	.18
7	-.03	-.09	.26	-.20	.05	-.09	.31	.10
8	-.01	.04	-.13	.09	-.08	.11	-.17	.03

Internal Consistency

Coefficient alpha values of the two subtests in each racial group are shown in Table 5. Internal consistency reliability for the White group was .76 for the verbal subtest; for the Native American group, alpha was .86. Alphas were also higher on the quantitative test for the Native Americans (.85) as compared to the Whites (.81).

Table 5
Coefficient Alpha Internal Consistency Reliability Coefficients by Subtest and Racial Group

Group	N	Subtest: Verbal	Quantitative
Whites	251	.76	.81
Native Americans	129	.86	.85

Correlation with High School Rank

Table 6 gives the correlations of verbal and quantitative test scores with high school rank. Verbal scores correlated .50 with high school rank for the Whites and .56 for the Native Americans. On the quantitative test, correlations were .47 for the Whites and .63 for the Native Americans. Differences between race group correlations were not statistically significant for the verbal test; but on the quantitative test, scores for the Native American group correlated significantly higher ($p<.05$) with high school rank ($r=.63$) than did scores for the White group ($r=.47$).

Table 6
Correlations of Verbal and Quantitative Scores with High School Rank, by Racial Group

	Subtest			
	Verbal		Quantitative	
Group	*N*	*r*	*N*	*r*
Whites	251	.50	251	.47
Native Americans	126	.56	129	.63

Discussion and Conclusions

This research analyzed a major standardized aptitude test for indications of item bias by comparing test data from a group of Native American high school students with those from a cohort group of White students. A systematic combination of approaches was used in the analysis of item bias. As a first step in the bias analysis, data from White students and from Native American students were separately factor analyzed and compared to factor structures which were derived from randomly generated item responses. Using the criterion that those real data factors which had eigenvalues greater than the corresponding random data factors would be retained, eight factors were extracted from the intercorrelations of the verbal test items for Whites and six verbal factors were extracted for Native Americans. Comparison of the factors between the two groups showed that the first verbal factor was quite similar for the two groups, but the other factors were not.

It is interesting to note that while the correlation of the first factors was .64, the coefficient of congruence relating the two sets of factor loadings was .94. Thus, the factors appeared to be much more similar when the levels of their loadings were included in the computation of the coefficient used for comparison. Church, Pine, and Weiss (1978), who also compared factor structures of verbal ability items between racial groups, reported a similar correlation (.58) between their White group's second factor and their Black group's first factor. Comparisons between their findings and those reported here for verbal data are difficult, however, because they did not report congruence coefficients and because the verbal ability tests used in the two studies were quite different.

Results were similar in the factor analyses of the quantitative data. Eight factors were extracted from the item intercorrelations for both groups.

First and second factors were fairly well related between groups. Loadings on the first factors correlated .73 in this study, as compared to .56 in the Church et al. analysis of quantitative items. The second factors correlated .70 in the present study and .39 in the Church et al. study. Thus, although the quantitative factors in the Church et al. study were not as strongly related between the two racial groups, the pattern of the correlations was somewhat similar between the two studies. As in the verbal data in the present study, the coefficient of congruence for the first factor of the quantitative data was much higher than the correlation coefficient (.94 compared to .73); but for the second factor, they were nearly identical (.70 compared to .69).

Unlike the Church et al. (1978) study of the structure of verbal and quantitative abilities in Whites and Blacks, the data from the present study indicate that the factor structures of verbal and quantitative abilities for Whites and Native Americans are fairly similar. Unfortunately, little research has been done on test bias in Native American groups; the bias literature is largely concerned with bias against Blacks and, to a lesser extent, Asians. The results of the present study are in accord with those of Follman, Miller, and Hernandez (1969), who factor analyzed scores on 22 subtests of various ability, achievement, and reasoning tests. Data were analyzed separately for three groups--"disadvantaged" Blacks, "disadvantaged" Blacks and Whites, and "nondisadvantaged" Whites. They found that the first three factors were similar for all groups and concluded that the abilities measured by these tests were the same across groups.

The first factor of each item response matrix accounted for sufficient variance to allow item parameterization according to methods based on ICC theory. ICC item difficulty estimates indicated that almost all items were more difficult for Native American students than for White students. Unlike the comparison of factor loadings between groups, coefficients of congruence comparing the item difficulties between the two groups were lower than the corresponding correlation coefficients. This implies that the pattern of item b values was similar between the two groups, but the level of those values was not as similar. Thus, although items tended to be ranked similarly in difficulty in each racial group, they were, in general, more difficult for the Native American students. According to Jensen (1974), if the rankings of items between groups are the same, then the test is not culturally biased and differences in test scores (and, consequently, item difficulties) across races are an indication of culture loading.

Another viewpoint defines item bias in terms of the relative subgroup differences in item difficulties. This approach has been operationalized by the use of indices such as elliptic-D to identify items which show large item-by-race interaction. Although previous proposals for the use of elliptic-D were based on item difficulty indices derived from classical test theory, in the present study the item b values from ICC theory were used in the computation of elliptic-D. To identify reliably biased items, the White group was randomly split in half and ICC b values were computed separately for each half. The maximum value of elliptic-D obtained in the comparison of the two White subgroups was used as the minimum value of elliptic-D to identify a biased item in the comparison of b values between the Native American group and the two White subgroups. An item was said to be reliably biased if the values of elliptic-D in both Native American vs. White comparisons exceeded the maximum value in the White 1 vs. White 2 comparison.

Results of the elliptic-D analysis indicated that there were no reliably biased verbal items; however, two quantitative items were reliably biased--one against Whites and one against Native Americans. These results are in agreement with those of other investigators (e.g., Breland, Stocking, Pinchak, & Abrams, 1974; Jensen, 1974) who, in general, have neither found indications of bias in standardized tests using classical psychometric item difficulties (proportion correct) nor transformed item difficulty statistics in their computation of elliptic-D or related indices.

Green (1972) suggested that internal consistency reliabilities are an appropriate index of test bias against minority groups, under the assumption that differing reliabilities would indicate that the scores of one cultural group contain more error than those of another cultural group. Verbal test data from Native American students had a substantially higher coefficient alpha internal consistency than did the White student data (.86 vs. .76). Similarly, coefficient alpha was slightly higher for the Native Americans on the quantitative test (.85 vs. .81). Both the factor analysis and elliptic-D results indicated that there was no general tendency for either the verbal or quantitative subtests to be biased, while the results of the internal consistency analysis suggested that bias against Whites was present in the verbal test. Since the results of these analyses led to different conclusions, the utility of the internal consistency criterion as an indication of item bias may be questioned.

These results also contrast with the Church et al. (1978) results, in which test responses of Black students were found to be less internally consistent than those of Whites for all three ability measures used. As indicated previously, the two studies cannot be directly compared, however, because of the different tests, as well as different minority groups, used in the two studies.

Probably the most important measure of a test's fairness is how well it predicts important psychological, educational, or occupational variables. Jensen (1975) has suggested that differential predictive validity is an indication that a test is culturally biased. In this study verbal test scores of Native American students were slightly better predictors of high school rank than verbal test scores of White students (r=.56 for Native Americans and r=.50 for Whites). While these differences were not statistically significant, quantitative test scores of Native Americans were significantly (p<.05) better at predicting high school rank than the corresponding scores of White students (r=.63 for Native Americans and r=.47 for Whites). Thus, by this criterion of bias, the SCAT-II quantitative subtest was biased against White high school students, at least in comparison to a cohort group of Native American students.

The data analyzed here clearly show that the standardized ability test studied, the SCAT-II, was not biased against Native American high school students. A between-groups comparison of the loadings on the major factors revealed that both the verbal test and the quantitative test were measuring similar abilities for each racial group. Regression of one group's ICC b parameters on the other group's b parameters and the elliptic-D analysis did not indicate that either group was at a disadvantage from the standpoint of biased items. The differential internal consistency reliabilities and predictive validities of these tests between races is difficult to explain.

The results clearly show, however, that different methods for studying test bias will lead to different conclusions. In the present study, the analysis of test bias at the item level led to the conclusion that essentially no bias existed in either subtest. Analysis of bias at the test level suggested the existence of bias against the majority group, rather than the minority group, for one of the subtests in each analysis. Since one of the analyses at the test level indicated more bias in the verbal test and the other in the quantitative test, the two methods did not lead to the same conclusion, suggesting that test level analyses of bias may be less appropriate than item level analyses.

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Appendix: Supplementary Tables

Table A
Eigenvalues of the First Eight Factors Extracted from the Random and Real Data Matrices for 46 Verbal Items, and Proportions of Total Variance for Real Data Factors for White (*N*=251) and Native American (*N*=129) Groups

Factor	Eigenvalues: Whites Random	Eigenvalues: Whites Real	Eigenvalues: Native Americans Random	Eigenvalues: Native Americans Real	Proportion of Total Variance: Whites	Proportion of Total Variance: Native Americans
1	1.88	6.36	2.69	10.07	.138	1.217
2	1.48	2.09	2.40	2.48	.045	.052
3	1.47	1.84	2.24	2.32	.040	.049
4	1.31	1.74	1.95	1.97	.038	.042
5	1.22	1.46	1.69	1.86	.032	.039
6	1.11	1.41	1.61	1.68	.031	.035
7	1.09	1.24	1.52	1.50	.027	--
8	.99	1.12	1.39	1.36	.024	--

Table B
Eigenvalues of the First Eight Factors Extracted from the Random and Real Data Matrices for 47 Quantitative Items, and Proportions of Total Variance for Real Data Factors for White (*N*=251) and Native American (*N*=129) Groups

Factor	Eigenvalues: Whites Random	Eigenvalues: Whites Real	Eigenvalues: Native Americans Random	Eigenvalues: Native Americans Real	Proportion of Total Variance: Whites	Proportion of Total Variance: Native Americans
1	1.82	8.44	2.67	10.41	.180	.222
2	1.54	3.33	2.44	3.59	.071	.076
3	1.47	1.94	2.39	2.74	.041	.058
4	1.41	1.71	1.92	2.35	.036	.050
5	1.30	1.53	1.72	1.91	.033	.040
6	1.25	1.29	1.64	1.83	.027	.039
7	1.14	1.16	1.49	1.64	.025	.035
8	1.03	1.07	1.44	1.58	.023	.034

Table C

Item Difficulty (*b*) Parameter Estimates for SCAT Vocabulary and Quantitative Test Items for the Two White Subgroups (W1,W2) and the Native American (NA) Group

Verbal								Quantitative							
Item	W1	W2	NA	Item	W1	W2	NA	Item	W1	W2	NA	Item	W1	W2	NA
1	-4.45	-8.49	-1.64	26	.23	1.37	.92	1	-2.30	-3.73	-3.55	26	.51	.31	1.06
2	-3.54	-1.63	-1.67	27	2.22	10.32	.65	2	-2.92	-5.96	-1.91	27	.14	.39	.73
3	-1.94	-2.02	-1.24	28	-.80	-.75	.08	3	-14.43	-5.14	-3.45	28	1.17	1.03	1.10
4	-.72	-.20	-.29	29	1.21	1.11	1.07	4	-1.36	-677.67	-.13	29	.59	.83	.98
5	-2.56	-1.27	-.23	30	.41	.43	*b*	5	*a*	-1.98	-2.16	30	1.08	2.16	2.63
6	-.52	-.58	-.07	31	2.35	3.49	2.00	6	-1.86	-2.07	-.60	31	-.34	-.08	.47
7	-.85	-1.20	-.42	32	.47	1.03	.70	7	*b*	*b*	*b*	32	1.67	*b*	1.53
8	-1.62	-.86	-.90	33	5.27	*a*	2.59	8	.03	-.36	.27	33	*a*	*b*	*a*
9	-.35	-1.87	.56	34	.71	*a*	1.26	9	-1.37	-.55	.26	34	.22	.60	.80
10	-.63	-1.17	-.09	35	1.41	.74	.89	10	-.14	-.12	.43	35	1.74	1.18	.89
11	*a*	-.27	-.07	36	.81	1.73	.47	11	-.32	-.40	.33	36	1.61	1.58	1.88
12	-1.13	-1.46	.22	37	1.65	*a*	*b*	12	-1.21	-.99	-.16	37	-.71	-.54	-.96
13	-.17	.24	.51	38	*b*	1.83	*b*	13	-.40	-.18	.40	38	-1.57	-1.01	-1.05
14	-.30	.14	.37	39	1.63	2.17	.97	14	1.09	1.75	.82	39	*b*	*b*	*a*
15	-.58	-1.90	-.76	40	*b*	2.84	*b*	15	-1.16	-2.13	-.31	40	-.23	.19	.36
16	-2.59	-2.14	-.48	41	1.21	.88	1.47	16	-.92	-.44	.05	41	.88	*b*	*b*
17	.42	.34	.46	42	*a*	3.68	*b*	17	-.34	-.12	.31	42	*a*	*a*	*a*
18	-1.14	-1.79	-.64	43	*b*	*a*	*a*	18	-1.58	-1.51	-.28	43	2.23	1.69	1.99
19	-1.32	-1.42	-.64	44	*a*	*a*	*a*	19	.03	-.07	.21	44	1.50	1.15	*b*
20	-2.00	-1.48	-.67	45	1.67	*b*	2.04	20	.18	-.17	*b*	45	*b*	*b*	1.60
21	-.77	-.15	.17	46	*a*	*a*	*a*	21	-1.32	-1.68	-.90	46	*a*	*a*	*a*
22	-.64	.00	.46	47	*a*	*a*	*a*	22	-.11	-.42	.02	47	*a*	*a*	*a*
23	*a*	-3.79	-.23	48	3.43	*a*	*a*	23	.57	.51	.69	48	*a*	*a*	*a*
24	-.09	-.42	.18	49	*a*	*a*	*a*	24	.16	.47	.35	49	1.73	*b*	*a*
25	.04	-.51	.22	50	*a*	*a*	*a*	25	.53	.25	.37	50	*a*	*a*	*a*

[a] Item *b* value was not estimated because proportion correct was less than .25.

[b] Item *b* value was not estimated because biserial correlation of item response with total score was 1.0 or greater.

Table D

Unrotated Principal Factor Matrix for Verbal Items in the White Group

Item	Factor 1	2	3	4	5	6	7	8	h^2
1	.26	-.57	.30	.34	.60	.06	-.24	.00	1.01
2	.51	-.14	-.03	.39	-.28	.27	.30	-.29	.84
4	.47	.05	-.10	.17	-.16	.12	-.25	.15	.41
5	.59	-.40	-.20	-.11	.09	-.16	.12	-.09	.62
6	.52	.02	.16	.13	-.23	-.01	-.22	-.21	.46
7	.42	.03	.30	-.01	.07	-.14	-.16	-.12	.34
8	.56	-.18	.11	-.17	-.09	-.07	.07	-.03	.39
9	.22	-.14	-.26	.10	.16	-.21	.08	.03	.23
10	.52	-.05	.13	.04	-.24	-.14	.10	.09	.38
11	.11	-.12	.09	-.40	-.14	-.22	-.09	-.05	.27
12	.35	.01	-.15	-.07	.07	.27	-.18	-.10	.26
13	.40	-.05	.36	.33	.04	.21	.04	-.05	.45
14	.48	-.17	-.05	.13	.00	-.14	.04	-.26	.37
15	.44	.06	-.18	.19	-.30	-.17	-.16	.17	.44
16	.31	-.05	.31	-.01	-.03	-.38	.16	.05	.38
17	.47	-.24	.00	-.02	-.06	-.06	.20	.04	.33
19	.31	-.04	.26	.03	.14	-.25	-.09	.00	.26
20	.55	-.19	-.50	-.24	.18	.11	-.23	-.04	.74
21	.34	.01	.04	-.22	.33	.24	.00	-.08	.35
22	.44	-.02	.12	-.05	-.16	-.01	-.01	.20	.27
23	.06	-.28	.11	-.02	-.24	-.12	.18	.09	.20
24	.58	.09	.10	.14	.00	-.07	-.24	.21	.49
25	.57	.17	-.32	-.07	-.08	-.21	.19	-.22	.60
26	.28	-.06	.09	-.03	.10	.17	.13	.29	.24
27	.08	.27	-.15	.16	.14	.18	.06	.21	.22
28	.43	.16	-.23	-.17	-.02	-.08	-.18	.08	.34
29	.38	.14	-.03	.09	.26	.07	.20	.06	.29
30	.47	.37	.15	-.06	-.05	-.19	.07	.18	.46
31	.17	.13	-.12	-.08	-.20	.13	-.25	-.02	.19
32	.40	.02	-.05	-.15	.06	.07	-.02	.00	.19
33	-.02	.07	-.02	.25	-.28	.20	-.15	.00	.21
34	.12	.14	.45	-.16	.03	.09	-.02	.20	.31
35	.44	-.01	-.34	.06	.18	.11	.05	.37	.50
36	.25	-.27	.26	-.22	-.24	.38	-.03	.04	.45
37	.14	.26	-.11	.05	.18	-.06	.08	-.02	.15
38	.36	.15	-.23	.15	.08	.08	.22	-.12	.30
39	.30	.10	-.07	.07	.05	-.14	.13	-.10	.16
40	.30	.44	.10	-.07	.01	.09	-.20	-.27	.42
41	.41	.13	.07	-.02	.16	-.02	.05	.10	.24
42	.06	-.10	-.04	-.06	-.15	.40	.23	-.08	.26
43	.38	.14	.28	-.29	.01	.24	.14	-.01	.40
45	.32	-.05	.01	.09	-.05	.12	-.20	-.14	.19
46	.29	.28	.08	-.59	.08	.06	-.01	-.08	.54
47	.22	.37	.02	.28	-.06	.07	.16	.30	.40
48	.00	.20	.14	-.11	.17	.10	.36	-.12	.25
49	.02	.52	.17	.31	.17	-.13	-.10	-.29	.53
Eigenvalue	6.36	2.09	1.84	1.74	1.46	1.41	1.24	1.12	

Table E
Unrotated Principal Factor Loadings for
Verbal Items in the Native American Group

	Factor						
Item	1	2	3	4	5	6	h^2
1	.31	.16	.17	.62	.02	-.22	.58
2	.36	.38	-.53	.04	.16	-.20	.62
4	.32	-.08	-.28	.08	-.17	.08	.23
5	.59	.01	-.06	.16	-.18	-.09	.42
6	.70	.05	-.06	-.33	-.18	.29	.72
7	.49	-.15	-.06	.09	.26	-.15	.36
8	.51	.39	-.37	.22	-.21	.39	.79
9	.53	-.36	-.04	.18	-.12	-.34	.57
10	.56	.04	-.21	-.27	-.14	-.23	.50
11	.37	.34	.46	.04	.07	-.12	.48
12	.40	.20	-.03	-.29	.16	-.13	.33
13	.42	.13	.36	-.01	.12	.09	.35
14	.70	-.01	-.18	.05	-.38	-.03	.67
15	.50	.15	.17	.02	.24	.05	.36
16	.52	-.01	.14	-.09	-.14	-.01	.32
17	.59	-.43	-.05	.00	-.08	-.20	.58
19	.40	.42	.30	.37	-.15	.10	.60
20	.65	.16	.02	-.08	-.18	-.24	.54
21	.34	.31	.20	-.23	.09	-.47	.53
22	.62	-.03	-.20	-.08	.07	.06	.44
23	.22	.34	-.17	-.04	.02	.00	.19
24	.73	-.06	.09	.14	-.08	.15	.59
25	.68	-.12	.02	.02	.14	-.21	.54
26	.43	-.18	.02	-.13	-.17	.06	.26
27	.44	.36	.30	-.28	-.21	-.05	.53
28	.43	.02	-.06	.13	-.04	.13	.22
29	.51	-.19	.20	.03	-.31	.01	.43
30	.65	-.21	.21	-.23	.01	.12	.58
31	.20	.16	-.15	-.12	.10	.44	.31
32	.46	-.11	-.39	-.04	-.07	-.16	.41
33	.16	.14	.00	.01	.43	-.10	.24
34	.38	.18	.14	-.30	.15	.10	.32
35	.55	.11	-.33	-.13	.18	-.06	.48
36	.48	.08	-.23	.19	-.02	-.04	.33
37	.57	-.16	.11	.20	.25	.22	.51
38	.24	.28	.21	.17	-.09	.02	.22
39	.52	-.11	.24	-.21	.39	.38	.68
40	.31	.18	.12	-.15	.00	-.02	.16
41	.35	-.31	.27	.09	-.11	.13	.33
42	.21	-.21	-.05	.08	-.00	.30	.19
43	.53	-.11	-.40	.07	.54	.08	.76
45	.27	-.28	-.05	.42	.10	.04	.34
46	.02	.30	.01	.45	.03	.05	.30
47	.40	-.48	.16	-.08	.11	-.17	.46
48	.28	-.08	.30	.19	.35	-.07	.34
49	.32	-.14	.08	-.06	-.28	.16	.24
Eigenvalue	10.07	2.48	2.32	1.97	1.86	1.68	

Table F
Unrotated Principal Factor Matrix for
Quantitative Items in the White Group

Item	Factor 1	2	3	4	5	6	7	8	h^2
51	.41	.01	.22	-.14	-.19	.08	.09	-.05	.30
54	.14	-.08	.23	.40	-.26	-.18	.01	.01	.34
55	.19	-.03	-.36	-.10	-.06	-.30	.04	.03	.28
56	.38	.00	.09	.14	-.44	.08	-.22	-.19	.46
57	.52	-.11	.08	.13	.09	-.08	-.14	.09	.36
58	.51	.00	-.15	.10	-.13	.03	-.26	.14	.40
59	.17	.04	.32	.13	-.01	-.14	-.10	.34	.29
60	.57	-.14	-.23	-.33	.16	.32	-.22	.20	.71
61	.54	-.17	.21	.14	.03	.27	-.12	-.10	.48
62	.47	-.19	.28	-.10	.16	.06	.04	.02	.39
63	.50	-.18	.21	.01	.14	.16	-.02	-.04	.37
64	.23	-.25	.13	-.14	.11	-.07	.16	.04	.20
65	.14	-.17	-.17	.28	-.07	-.01	.16	-.07	.20
66	.61	-.26	-.46	.10	-.06	.12	-.27	.02	.73
67	.62	-.17	-.15	.03	.18	-.12	-.10	-.08	.49
68	.56	-.16	-.27	-.40	-.28	.18	.05	.10	.69
69	.55	-.08	.04	-.21	-.05	.05	.08	-.10	.38
70	.61	-.03	.06	.02	-.38	-.06	.12	.05	.53
71	.44	-.08	.02	-.05	.09	-.22	-.12	.15	.29
72	.57	-.37	-.05	-.21	.09	-.12	-.10	-.10	.54
73	.24	-.04	.44	.19	-.08	.03	-.24	.01	.36
74	.40	-.04	.25	-.21	-.01	-.09	-.18	.12	.31
75	.52	-.27	-.19	.00	.03	-.36	.16	.12	.55
76	.38	-.21	-.10	-.09	.07	.06	.23	.06	.26
77	.46	.00	-.06	-.20	-.01	.17	.13	.08	.31
78	.27	-.40	-.13	.20	.34	-.17	-.09	-.05	.45
79	.38	.08	.15	.00	-.44	-.20	-.06	.02	.40
80	.27	.05	.23	.15	-.09	.15	.19	-.15	.23
81	.61	-.05	.18	.05	.00	.24	.06	.00	.47
82	.41	-.31	.05	.10	.20	-.02	.15	.27	.41
83	.39	-.28	.27	.06	.29	.02	.19	-.15	.44
84	.46	-.04	-.02	.14	-.31	.07	.37	-.09	.49
85	.30	.07	.06	-.05	.01	.11	.11	.05	.13
86	.38	.05	-.03	-.12	.16	-.22	-.04	-.42	.42
87	.43	.47	-.24	.33	.11	.03	-.04	-.18	.61
88	.58	.73	-.33	.26	.10	.07	.08	.06	1.08
89	.31	.16	.01	.30	.32	-.01	.09	.05	.33
90	.51	.45	-.11	.03	.14	-.07	-.06	-.32	.60
91	.62	.21	.12	-.08	.00	-.11	.19	.01	.49
92	-.10	.28	-.04	.14	.05	.25	-.07	.09	.19
93	.28	.52	-.01	-.19	.01	.09	.17	-.12	.44
94	.40	.35	-.06	-.28	.00	.00	.17	.02	.39
95	.38	.32	.02	.09	-.12	.04	-.24	-.04	.33
96	-.14	.08	-.02	.40	.08	.43	.13	.31	.49
97	.24	.51	.35	-.35	.23	-.01	-.30	.00	.70
99	.30	.54	-.11	.04	-.09	-.28	.00	.40	.64
100	.10	.45	.37	.05	.14	-.21	.16	.12	.46
Eigenvalue	8.44	3.33	1.94	1.71	1.53	1.29	1.16	1.07	

Table G
Unrotated Principal Factor Loadings for
Quantitative Items in the Native American Group

Item	Factor 1	2	3	4	5	6	7	8	h^2
51	.38	.43	.60	.41	.07	.26	.14	-.14	.97
54	.58	.05	-.41	-.17	-.05	-.06	-.12	.13	.57
55	.21	-.20	.28	.17	.36	.06	.26	.47	.61
56	.65	.01	-.25	.05	-.07	.15	.07	.14	.54
57	.76	-.15	-.05	.15	.05	.11	.07	.14	.66
58	.42	-.07	.16	-.19	.11	.23	-.10	-.03	.32
59	.34	-.18	-.35	.04	.07	.34	-.02	-.08	.40
60	.75	-.22	.02	.06	.20	-.10	-.13	.12	.70
61	.55	-.17	.11	-.04	-.13	.05	-.06	.03	.37
62	.62	.04	-.12	-.07	-.09	-.14	.06	.10	.45
63	.40	-.24	.14	.08	.15	.31	-.02	.05	.36
64	.46	.31	-.02	-.23	.15	-.12	.27	-.33	.58
65	.36	-.26	.10	.22	-.29	.11	.12	.13	.38
66	.72	-.10	.24	-.17	.05	-.09	-.06	.02	.63
67	.72	.03	-.12	-.01	.01	-.27	-.03	.10	.62
68	.57	-.36	.23	.13	.07	-.03	-.13	-.23	.60
69	.61	.06	.05	.04	-.24	.01	.02	.25	.50
70	.75	-.04	-.01	.05	-.03	.02	-.03	.00	.57
71	.43	-.07	.33	-.44	.22	-.38	.04	.09	.69
72	.55	-.12	-.11	-.00	-.27	-.29	-.15	-.05	.51
73	.49	-.10	-.31	-.05	-.39	.15	-.10	.03	.53
74	.41	.01	-.05	-.05	.27	.26	-.04	-.33	.42
75	.68	.00	-.45	.07	-.09	.32	.05	-.14	.80
76	.49	.00	.43	-.18	.10	-.27	-.16	.04	.57
77	.36	.20	-.19	.06	.18	.04	.40	.51	.66
78	.50	-.06	-.06	-.31	.32	.35	-.07	-.12	.60
79	.42	-.12	-.17	.07	.13	-.11	-.14	.21	.32
80	.21	-.01	-.51	.09	.05	-.46	.08	-.07	.54
81	.57	-.02	-.10	.36	.25	-.03	-.27	-.06	.60
82	.37	-.02	-.06	-.34	-.33	.11	.34	-.11	.50
83	.26	.27	-.02	-.32	-.18	-.22	.19	-.20	.40
84	.57	-.06	-.04	.36	-.01	-.20	.20	-.14	.56
85	.49	.26	-.09	-.08	.05	-.07	.28	.11	.42
86	.18	.28	.39	-.09	-.07	-.03	.10	-.22	.34
87	.18	.78	-.09	-.19	.17	-.20	.47	.21	1.00
88	.50	.74	.17	.11	.14	-.12	-.30	.08	.97
89	-.10	.34	-.27	.03	.40	.11	-.07	-.14	.40
90	.41	.40	.29	.41	.04	.00	-.20	-.06	.62
91	.39	.18	-.00	-.02	.29	-.11	.13	-.05	.30
92	-.17	.40	-.20	.48	-.06	-.12	.27	-.00	.55
93	.19	.42	-.12	-.14	.02	.31	.06	-.08	.35
94	.57	.12	.20	.21	.03	-.15	.03	-.40	.61
95	.25	.50	.21	.16	-.26	.02	.25	-.15	.54
96	-.28	.43	.09	.60	.04	-.01	-.05	.16	.66
97	.11	.39	.53	-.35	-.54	.26	.02	.29	1.00
99	.23	.27	-.06	.20	-.23	.19	-.12	-.12	.29
100	.09	.27	.06	-.03	.21	.21	.49	-.04	.42
Eigenvalue	10.41	3.59	2.74	2.35	1.91	1.83	1.64	1.58	

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